	Type	Hits	Search Text
62	BRS	214	stopper and (rubber with (inject$4 near4 mold$3))
63	BRS	2640	injection with molding with cap
64	BRS	166	220/$.ccls. and (injection with molding with cap)
65	BRS	351	215/$.ccls. and (injection with molding with cap)
66	BRS	252	264/$.ccls. and (injection with molding with cap)
67	BRS	4616	rubber with injection with molding
68	BRS	476	264/$.ccls. and (rubber with injection with molding)
69	BRS	19	stopper and (264/$.ccls. and (rubber with injection with molding))
70	BRS	24	215/$.ccls. and (rubber with injection with molding)
71	BRS	35979	(syringe near$4 cap) with mold$3
72	BRS	11	(syringe adj cap) with mold$3
73	BRS	11911	(inject$3 with mold$3) and ((syringe near$4 cap) with mold$3)
74	BRS	4	(inject$3 with mold$3) same "syringe cap"
75	BRS	6188	(inject$3 with mold$3) same cap
76	BRS	129	"hot runner" and ((inject$3 with mold$3) same cap)

United States Patent [19]

Deussen

[11] **4,134,511**

[45] **Jan. 16, 1979**

[54] **CONTAINER WITH FRANGIBLE SEAL**

[75] Inventor: **Werner Deussen**, Eltville, Germany

[73] Assignee: **Stella KG Werner Deussen**, Walluf, Germany

[21] Appl. No.: **821,969**

[22] Filed: **Aug. 4, 1977**

[30] **Foreign Application Priority Data**

Nov. 27, 1976 [DE] Fed. Rep. of Germany 2653993

[51] **Int. Cl.**[2] **B65D 17/24**

[52] **U.S. Cl.** **215/32**

[58] **Field of Search** 215/32; 222/541

[56] **References Cited**

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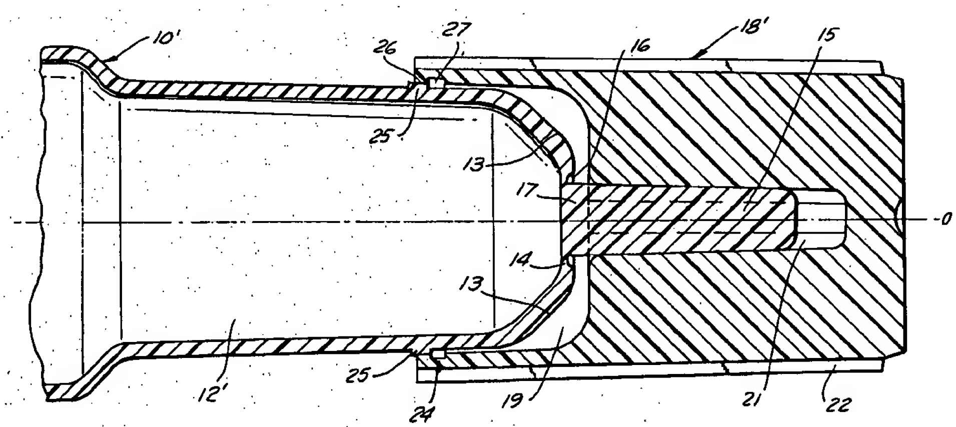
Primary Examiner—Donald F. Norton

Attorney, Agent, or Firm—Karl F. Ross

[57] **ABSTRACT**

A nonrefillable container for medication and other liquid, pasty or granulated products to be kept sterile has a body of flexible resinous material, such as polyethylene or polypropylene, with a neck terminating in a solid tip which is integrally connected therewith via a reduced wall portion forming a frangible annular link whose rupture creates an outlet for the contents. The neck is surrounded in an airtight manner by a protective cap forming a socket firmly gripping the tip, the socket and the tip being of mating noncircular cross-section whereby rotation of the cap facilitates rupture of the link and withdrawal of the cap with the tip attached thereto. The cap and the neck may have complementary annular formations which interengage when, after break-off of the tip, the neck is pushed deeper into the cap than theretofore. To insure a tight initial fit free from contamination, the cap and the container are concurrently produced by injection molding and are assembled in a sterile environment while still hot from the mold.

8 Claims, 8 Drawing Figures



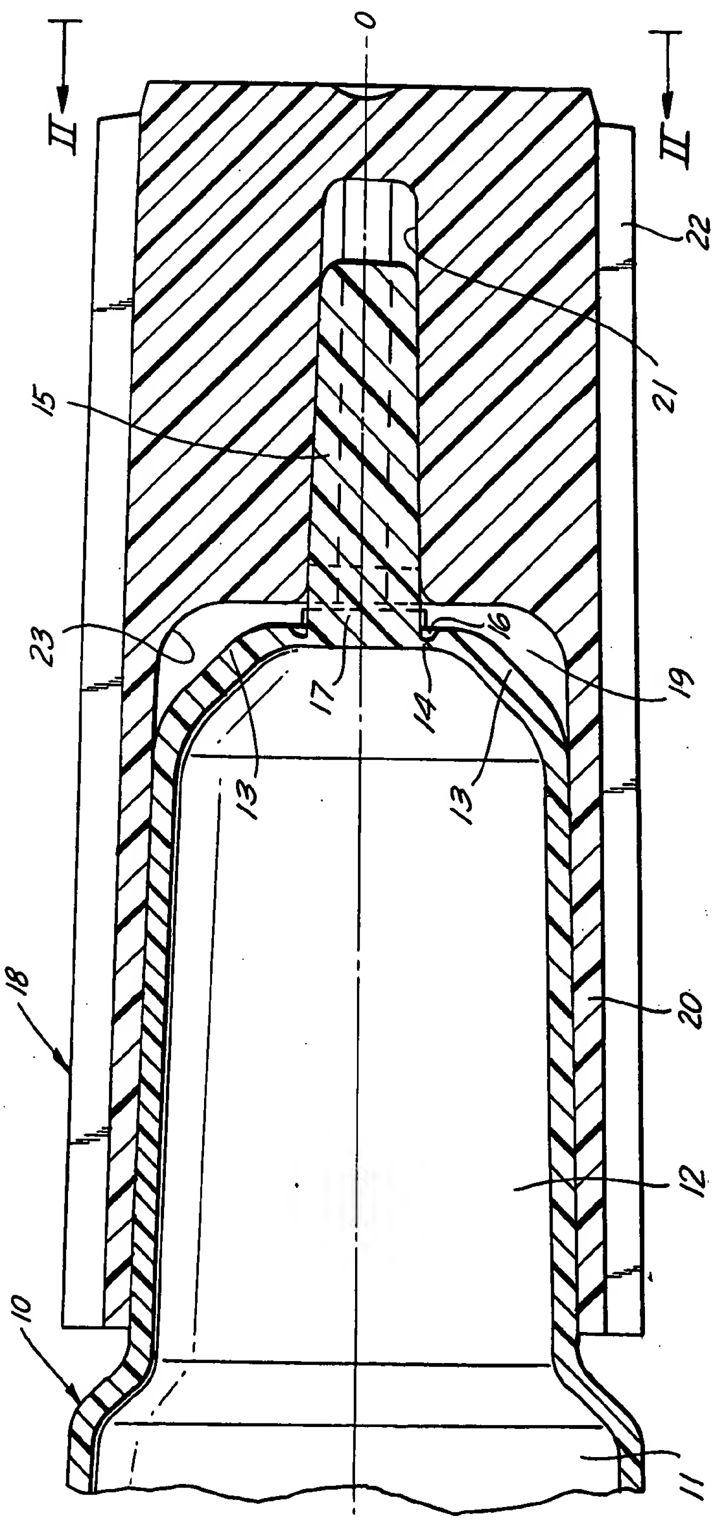


FIG. 1

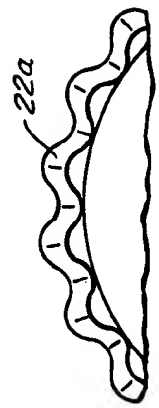


FIG. 3a

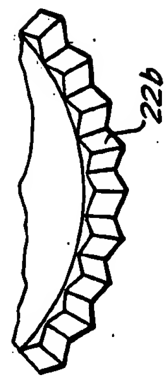


FIG. 3b

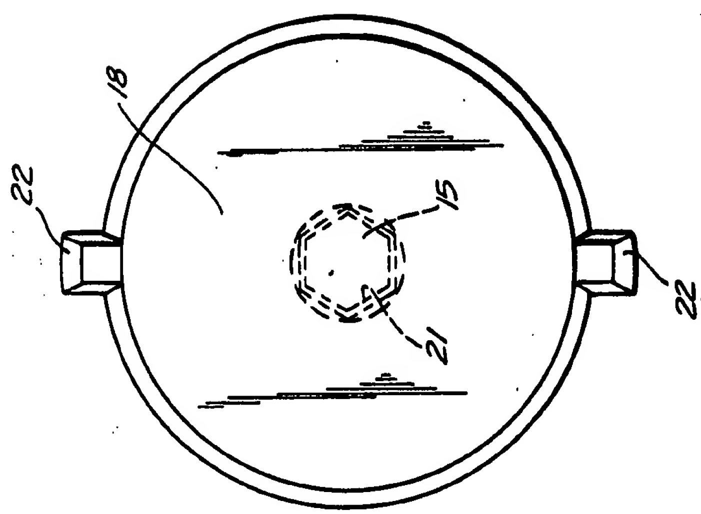


FIG. 2

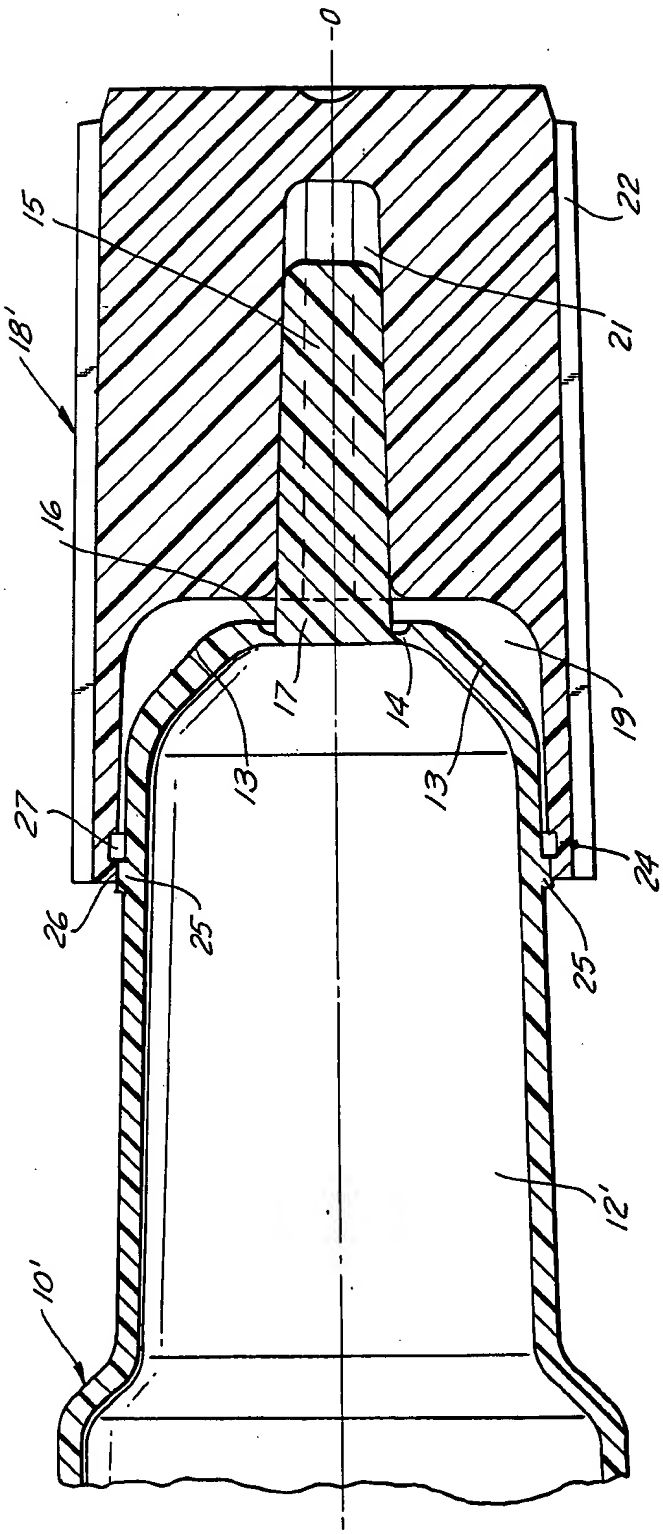


FIG. 4

FIG. 5

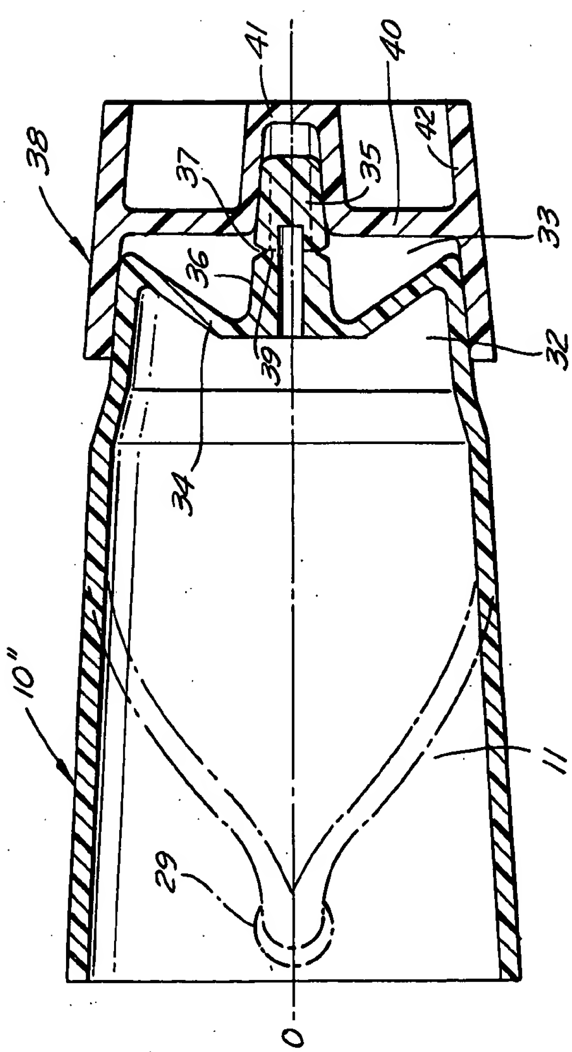


FIG. 6

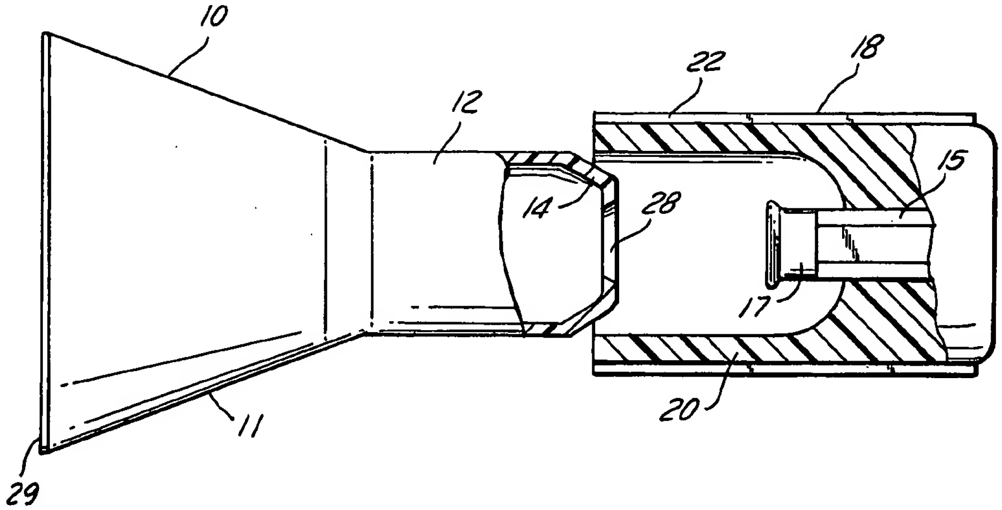
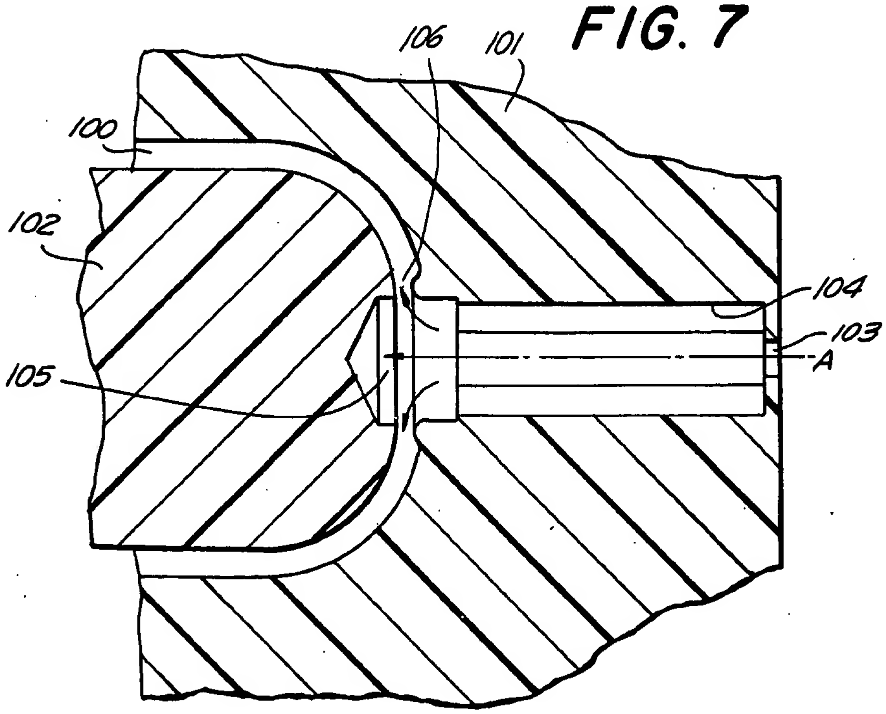


FIG. 7



CONTAINER WITH FRANGIBLE SEAL

FIELD OF THE INVENTION

My present invention relates to a nonrefillable disposable container in which medication or other dispensible products of liquid, pasty or granular consistency are sealed against the atmosphere and thus kept sterile before being used.

BACKGROUND OF THE INVENTION

Conventional containers of this character, usually made of plastic material, have a hollow body which is sealed after filling but has a neck with a tab which exposes an outlet for its contents upon being pulled off. If the container is emptied only in part, the neck can be covered with a separately supplied closure cap, preferably after a temporary plugging of the outlet with a wad of cotton; see, in this connection, German printed specification No. 1,965,761. It has also been proposed (see German published application No. 24 46 564) to make the cap integral with the free end of a frangible neck extension which after rupture can thus be inverted to close the outlet.

In all these instances, the container surface surrounding the tab or frangible neck extension is unprotected and therefore subject to contamination by handling and by exposure to the atmosphere; the interior of the closure cap is similarly exposed. Thus, sterility of the product subsequently poured from the outlet cannot be assured unless the container and the cap, after sterilization, are hermetically sealed in an external wrapper which, of course, adds to the cost of the item.

Another problem is that the outlet created by the forcible break-off of a frangible neck extension generally has an irregular and often jagged boundary which is not only unsightly but also potentially dangerous.

A further drawback of conventional disposable containers of flexible plastic material is that the finger pressure required to hold the container body during exposure of the outlet tends to squeeze out some of its contents at the instant of rupture, thus causing spillage of the product on the skin or the garments of the user.

OBJECTS OF THE INVENTION

The important object of my present invention, therefore, is to provide a container of the character described which obviates the aforestated disadvantages.

SUMMARY OF THE INVENTION

In accordance with my present invention, a sealed hollow container body has an extremity (referred to hereinafter as a neck) provided with an elongate solid projection or tip which is integrally connected thereto via a reduced wall portion forming a frangible annular link whose rupture creates an outlet for the product stored in the container. The neck is closely surrounded, in an airtight manner, by a protective cap which firmly engages that tip and cannot be detached from the container body until the tip has been broken off.

The close fit of the cap around the neck prevents the entry of germs and other contaminants into the region around the tip so that joint removal of the cap and the tip exposes a previously untouched container surface surrounding the newly formed outlet. Furthermore, the presence of the cap during storage and transportation of the sealed container protects its tip against premature rupture even if the link connecting the tip to the container body is rather frail. Thus, the link may be constituted by a very thin wall portion of the container neck (e.g. a fraction of a millimeter thick) whose severance leaves a clean break.

According to a further feature of my invention, the tip is received with press fit in a socket of the protective cap for rotatable entrainment, relative to the container body, about the neck axis. Thus, the tip and the socket may have mating noncircular cross-sections through which the user can exert upon the connecting link a torque greater than that which could be applied to it if the tip were directly gripped with the fingers.

In order to insure that the neck portion embraced by the cap is unsoiled at the time of assembly, the interfitting of the neck and the cap should take place under noncontaminating conditions. Such assembly, therefore, is advantageously carried out in a sterile environment when the container body and the cap, concurrently produced by injection molding, are both still hot from the mold and therefore do not carry any germs. The container and the cap are preferably molded from the same or similar elastomeric resins such as polyethylene or polypropylene.

In the case of a disposable single-dose container, whose contents are to be used only once, the cap serves only the aforedescribed purposes of preventing contamination and simplifying the rupture of the tip. If, on the other hand, the container is to be emptied in successive stages, the cap may also be used to reclose the outlet between discharges. Upon re-use, the container neck can be pushed more deeply into the cap for reclosure to provide a tighter seal, provided that the bottom of the cap formed with the socket is initially separated from a confronting end wall of the neck carrying the tip. Advantageously, the container neck and the cap are provided with mutually complementary annular peripheral formations such as a ridge and a groove which interengage when the cap is thus repositioned, thereby preventing its accidental dislodgement.

According to another advantageous feature of my invention, the frangible tip is attached to the end wall of the container neck not directly but with interposition of a tubular section acting as a nipple or spout when the tip is subsequently broken off. The presence of such a nipple is particularly useful with eye, ear or nose drops as well as with other medications to be applied rectally or vaginally, for example.

BRIEF DESCRIPTION OF THE DRAWING

The above and other features of my invention will now be described in detail with reference to the accompanying drawing in which:

FIG. 1 is a fragmentary sectional view of a container according to my invention, showing the container neck provided with a protective cap;

FIG. 2 is an end view of the cap as seen on the line II — II of FIG. 1;

FIGS. 3*a* and 3*b* are partial end views of a modified cap;

FIG. 4 is a fragmentary sectional view similar to FIG. 1, illustrating other modifications;

FIG. 5 is a longitudinal sectional view of a container and cap constituting a further embodiment;

FIG. 6 is a partly sectional view, drawn to a smaller scale of the container and the cap of FIG. 1 separated from each other; and

FIG. 7 is a schematic cross-sectional view of an injection mold designed to produce a container according to my invention.

SPECIFIC DESCRIPTION

In FIGS. 1 and 2 I have shown a container 10 comprising a hollow body 11 having a reduced neck 12. The opposite end of container body 11, not shown in FIG. 1 but seen in FIG. 6, is pinched closed by a sealing strip 29 after the container has been filled with a medicament or some other product in liquid, pasty or granular form.

A generally hemispherical end wall 13 of neck 12, centered on an axis 0, has an annular depression 16 surrounding a solid tip 15 integral with the container body. Tip 15 has a circularly cylindrical portion 17 close to neck 12 but is of polygonal (i.e. hexagonal) cross-section over the greater part of its length as seen in FIGS. 2 and 6. Tip 15 is received with a press fit in a correspondingly profiled socket 21 of a protective cap 18 whose peripheral wall 20 closely surrounds the neck 12 in airtight fashion. The contact surfaces of neck 12 and wall 20 as well as those of tip 15 and socket 21 are slightly tapered in a direction away from container body 11, thereby limiting the extent to which the neck can be inserted into the cap. Thus, the wall 13 is held separated by an axial clearance 19 from the confronting cap bottom 23. The cap 18 cannot be detached from the neck 12 by an axial pull as long as tip 15 remains intact.

The part of wall 13 weakened by the depression 16 constitutes a rupturable link 14 along which the tip 15 is severed from the neck 12 upon relative rotation of the container 10 and the cap 18 about their common axis 0. To facilitate such relative rotation, I prefer to provide the cap 18 with external gripping formations such as ribs 22 (FIGS. 1 and 2), undulations 22*a* (FIG. 3*a*) or serrations 22*b* (FIG. 3*b*). The outer edge of depression 16 diverges from axis 0 at an angle of about 30° to form a transition zone turning into a smooth boundary for a central outlet 28 which comes into existence when the tip is twisted off; only then can the cap be separated from the container, together with the tip 15, as shown in FIG. 6.

The container and the cap are molded from resinous, preferably elastomeric material such as polypropylene. In order to insure that the area 13, 14 of neck 12 surrounding the tip 15 is free from contaminants when the container and the cap are interfitted, it is advantageous to produce both by injection-molding in an environment of sterilized air under a pressure slightly higher than atmospheric and to assemble them promptly after ejection from the mold, while they are still hot and therefore absolutely germfree.

Certain precautions should be observed in the molding of a container of the type illustrated in FIG. 1 whose wall thickness at the frangible link is very small (e.g. only a few tenths of a millimeter). Since even a minor eccentricity of a mold cavity defined by two separate members, namely the mold proper and a core, tends to be magnified upon the injection of the fluid thermoplastic material, holes or cracks could develop at that point unless the core is precisely centered relatively to the mold. I have found that such centering is facilitated if, as illustrated in FIG. 7, the container is formed in a cavity 100 between a mold 101 and a core 102 with central injection of the mass through a gate 103 into a channel 104 conforming to the tip 15 of the container, this tip thus serving as a large-diameter hot runner. A recess 105 in core 102, aligned with channel 104, receives the so-called cold slug in the initial stage of injection (arrow A); after the channel 104 fills up, the injected mass spreads out laterally through a surrounding annular constriction 106 (designed to form a reduced wall portion 16) acting as a fan gate, the thermoplastic material thereupon passing into the cavity 100 in an essentially laminar flow to form the container body 11 and its neck 12. Extraction of the finished container from the mold cavity is facilitated by the aforedescribed taper of its body including the neck and the tip. Recess 105, whose presence helps maintain the coaxial orientation of mold 101 and core 102, results in the formation of an inward extension of tip 15 which has no functional significance in the finished article and has not been illustrated in FIGS. 1 and 6. The socket 21 of the concurrently molded cap 18 should be so dimensioned as to provide the desired forced fit when shrinking around the tip 15 upon final cooling after assembly.

In FIG. 4 I have shown a container 10′ and a cap 18′ differing from their counterparts in FIG. 1 by being provided with a detent, generally designated 24, comprising an annular rib 25 on container neck 12′ initially in contact with an internal annular shoulder 26 at the rim of cap 18′. An annular groove 27 on the inner cap surface, immediately behind shoulder 26, accommodates the rib 25 when the cap is pushed further onto the neck even as the cylindrical end 17 of the twisted-off tip 15 enters the outlet 28 (FIG. 6). Rib 25 snaps into groove 27 when the end wall of neck 12′ contacts the bottom of cap 18′ so that outlet 28 plugged by the tip 15 is also peripherally sealed to prevent leakage of the contents to the outside; detent 24 acts as a further barrier against such leakage as well as against the intrusion of ambient air and dirt. A slight bevel of the edges of rib 25 and groove 27 enables disengagement of the cap 18′ from the neck 12′.

If desired, the rib 25 could be so positioned with reference to the groove 27 as to engage in that groove already upon initial assembly. The clearance 19 may then be correspondingly narrowed so that the wall 14 contacts the cap bottom in that position of engagement, especially if the container is not to be emptied at once.

A container 10″, shown in FIG. 5, differs from containers 10 and 10′ of the preceding FIGURES by having its neck 32 formed with a frustoconically re-entrant end wall 34 that is axially extended into a tubular section 36 aligned with a tip 35 from which it is separated by an annular depression 37 defining a rupturable link or break-off point 39. A coacting cap 38 has a bottom 40 with a thimble-shaped boss 41 forming a socket for the tip 35, the socket and the tip being again advantageously provided with mating polygonal or otherwise noncircular cross-sections for positive rotary coupling. When the tip 35 is twisted off at the depression 37, by relative rotation of the cap and the container body as described above, tubular section 36 forms a nipple or spout for the dropwise administration of medication to not readily accessible parts of a patient's anatomy, for example; pressure exerted through the flexible container wall upon the stored substance then deforms the end wall 34 to extend the nipple 36 outwardly. The clearance 33 initially separating the wall 34 from the cap bottom 40 allows the peripheral wall 42 of the cap 38 to be pushed further up the container neck 32 upon reclosure, the axially re-entrant configuration of wall 34 allowing the tubular section 36 to be thrust inwardly by the tip 35 during this operation. Section 36 and tip 35 are frustoconical and frustopyramidal, respectively, with com-

mon generatrices. Neck 32 and peripheral wall 42 could, of course, be provided with detent formations such as the rib 25 and the groove 27 of FIG. 4.

A re-entrant end wall 34 as shown in FIG. 5 could also be used in lieu of the generally hemispherical end wall 13 f container 10 r 10', FIGS. 1 and 4, in combination with a tip 15 linked to the container neck by way of a surrounding wall portion 14 of reduced thickness. Thus, a container with a convex end wall 13 can be used as a direct applicator of medication to a wound, for instance, whereas one with a concave end wall 34 (without nipple 36) may serve as a distributor of powder, for example, over a larger skin area.

FIG. 5 also shows, in phantom lines, the sealing of the opposite (left-hand) end of the container body after it has been filled, again with the aid of a strip 29.

Conventional techniques, such as the use of multipartite molds and/or collapsible cores, are available for producing the containers 10' and 10" together with the asssociated caps by an injection-molding process generally similar to that described with reference to FIG. 6.

I claim:

1. A nonrefillable container for dispensable products to be stored under sterile conditions, comprising:

a sealed hollow body having an extremity centered on an axis with an end wall and a solid axially extending projection on said end wall integrally connected therewith via a frangible link whose rupture creates an outlet for the contents of said body; and

a protective cap surrounding said extremity in close contact therewith, said cap having a bottom separated by an axial clearance from said end wall and formed with a socket receiving said projection in mating engagement therewith, said cap being inseparable from said body without rupture of said link, said cap and said extremity being provided with mutually complementary annular formations axially offset from each other and interengageable with a snap fit upon a repositi ning of said cap on said extremity after a separation therefrom and detachment of said projection to permit a partial discharge of said contents by way of said outlet, said bottom coming to rest against said end wall and forming a seal around said outlet upon interengagement of said formations.

2. A container as defined in claim 1 wherein said formations are a groove near the rim of said cap and a rib on said extremity overlain by said rim.

3. A container as defined in claim 1 wherein said projection and said socket are positively coupled for joint rotation about a common axis.

4. A container as defined in claim 3 wherein said projection and said socket have mating noncircular cross-sections.

5. A container as defined in claim 3 wherein said cap is provided with external formations facilitating rotation thereof relative to said extremity.

6. A container as defined in claim 1 wherein said projection, said socket and contact surfaces of said extremity and said cap are tapered in a direction away from said body.

7. A container as defined in claim 1 wherein said end wall is generally hemispherically convex.

8. A container as defined in claim 1 wherein said body and said cap consist of elastomeric material.

* * * * *

United States Patent [19]

Süss et al.

[11] 4,205,950

[45] Jun. 3, 1980

[54] **INJECTION MOLDING APPARATUS**

[75] Inventors: **Georg Süss**, Vilsbiburg; **Gerold Keil**, Helmstedt, both of Fed. Rep. of Germany

[73] Assignee: **Linde Aktiengesellschaft**, Wiesbaden, Fed. Rep. of Germany

[21] Appl. No.: **907,627**

[22] Filed: **May 19, 1978**

[30] **Foreign Application Priority Data**

May 21, 1977 [DE] Fed. Rep. of Germany 2723071

[51] **Int. Cl.**[2] **B29F 1/08**; B29D 3/00

[52] **U.S. Cl.** .... **425/126 R**; 264/237; 264/318; 425/129 R; 425/404; 425/548; 425/552; 425/575

[58] **Field of Search** .... 425/533, 552, 575, 576, 425/126 R, 129 R, 190, 404, 547, 548; 264/318, 237

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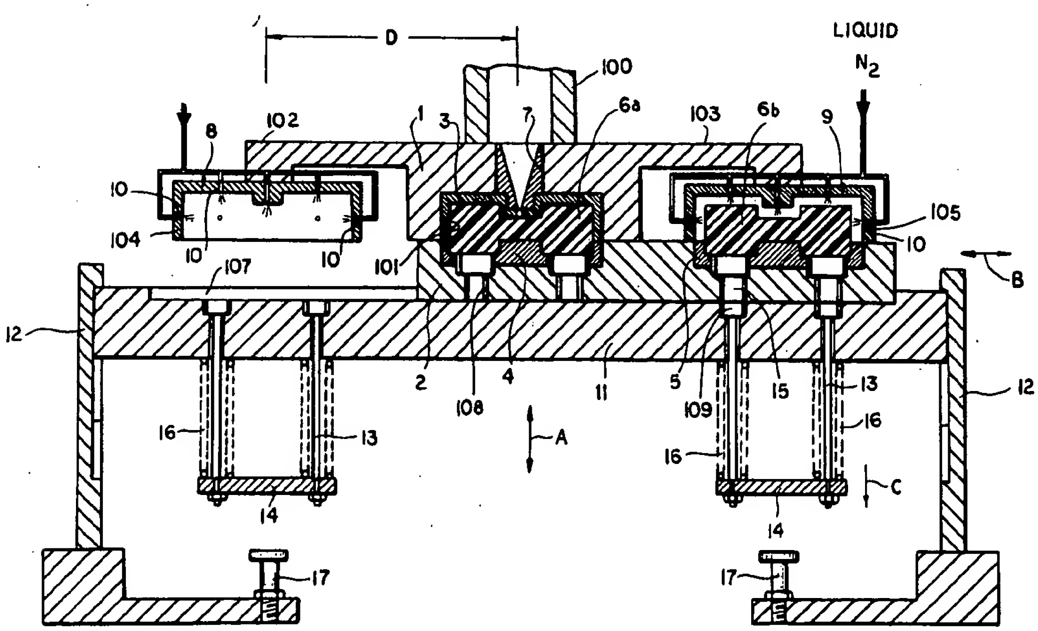
Primary Examiner—Thomas P. Pavelko

Attorney, Agent, or Firm—Karl F. Ross

[57] **ABSTRACT**

Synthetic-resin articles are injection molded with at least one stationary mold cavity on the stationary mold plate being alternately aligned with carriers on the mold-closure plate so that each article is entrainable by this plate into a working station in which, for example, it can be cooled. During the injection molding of one article in the mold cavity defined between the stationary mold half and one of these carriers, a previously molded article is solidified on the other carrier in a working station offset from the stationary mold half. The newly injected mass is retained in the mold cavity only until the surface regions have cooled and set and the plate is then laterally shifted perpendicular to the mold closing direction to carry the article having the set surface regions and still fluid core into a working station while the other carrier, from which the cooled article has been ejected, is aligned with the stationary mold cavity.

9 Claims, 5 Drawing Figures



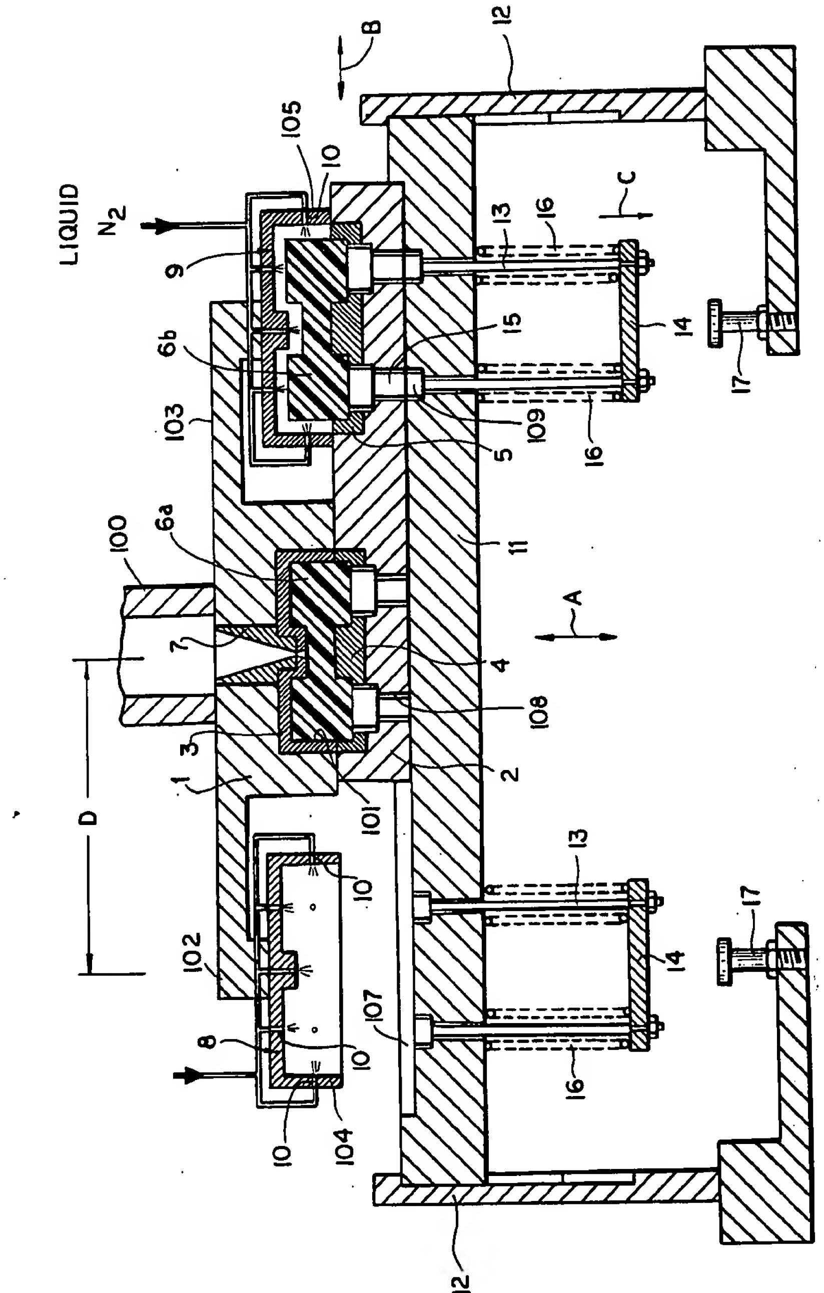

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FIG. 1

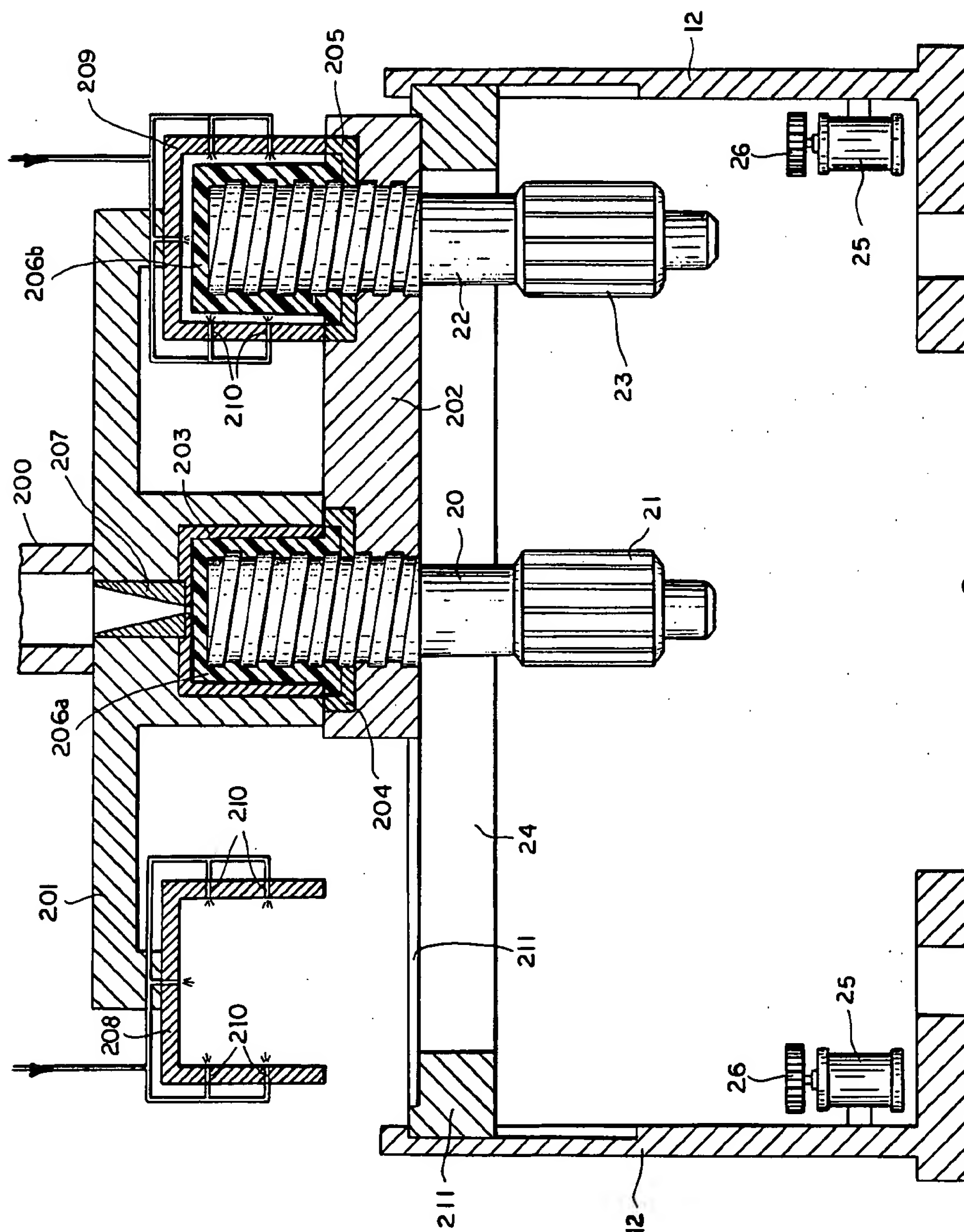

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FIG. 2

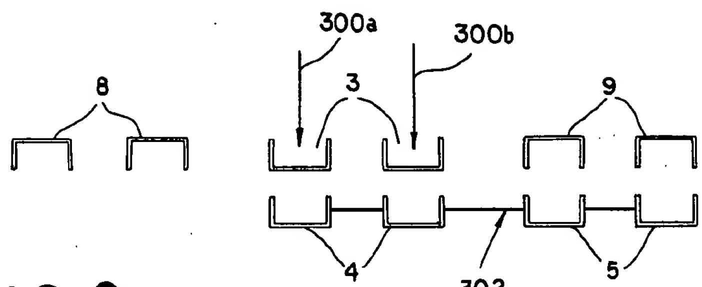

FIG. 3a

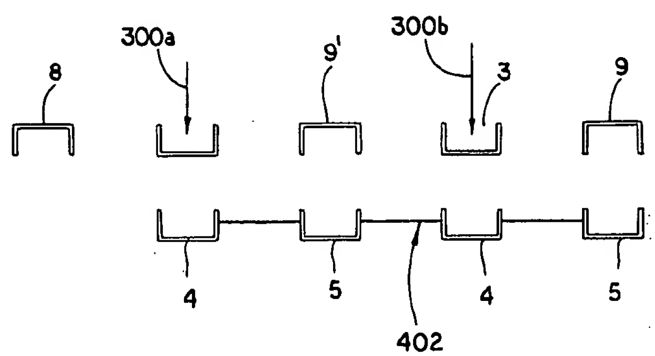

FIG. 3b

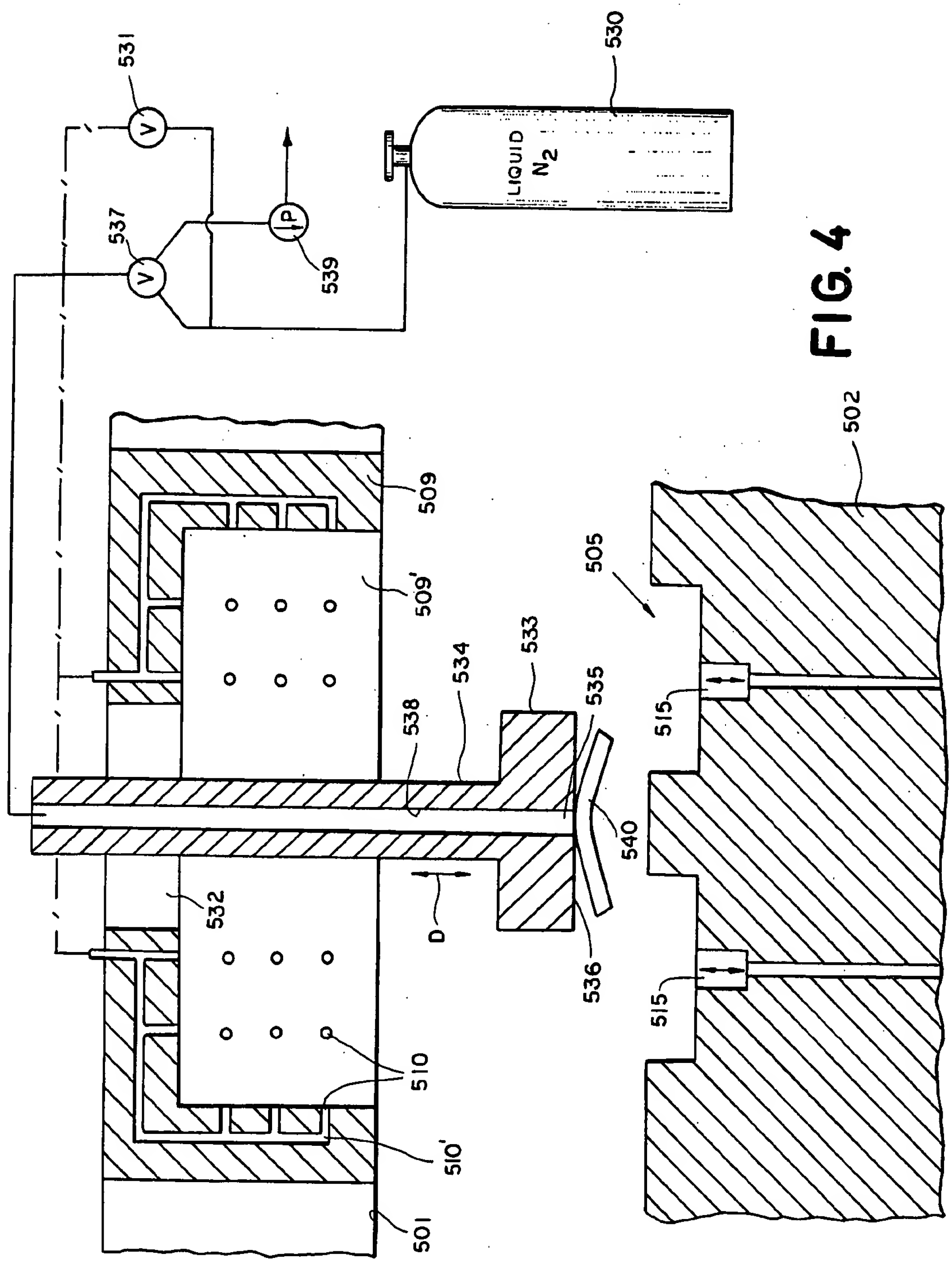
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FIG. 4

INJECTION MOLDING APPARATUS

FIELD OF THE INVENTION

The present invention relates to an apparatus for injection molding articles from a synthetic resin and, more particularly, to a system for the sequential production of injection-molded articles in an automatic injection molding machine.

BACKGROUND OF THE INVENTION

In an injection-molding process, a plastified mass of a synthetic resin material is introduced under pressure (injected) into a closed mold forming a mold cavity which is filled by the flowable mass of synthetic resin. The latter is customarily at a temperature above its plastic-flow temperature and generally above its melting point.

Upon cooling, the mold is opened and the article is ejected.

Injection molding systems of conventional types operate under a variety of modes.

For example, a predetermined quantity or dose of homogeneously melted or plastfied synthetic-resin material is injected under high pressure into a mold cavity which is complementary to the configuration of the article to be produced, i.e. is a negative of this article. The mold cavity is generally defined between two or more mold parts which are separate to allow release of the molded article and which are cooled.

The dose or quantity of the synthetic-resin material is a function of the volume of the mold cavity and is generally precisely dimensioned by introducing the necessary quantity of the material from an injection nozzle via an injection cylinder communicating with the mold cavity.

The injection cylinder is customarily provided with an injection piston which has a stroke sufficient to advance the mold material from the dosing chamber into the mold cavity.

As soon as the injection-molded material hardens by heat abstraction by the mold wall, i.e. by heat transfer to the latter, the mold cavity is opened and the molded article is ejected from the mold cavity. The mold is then closed and the process begins anew.

The cooling of an injection-molded article by heat transfer from the mold bodies through the mold wall of the cavity has been found to be relatively slow. Since the ejection of the injection-molded article from the mold cavity with the usual ejectors can only be effected when the injection molded article is hardened to its core, the heat transfer required for cooling the article must continue from the point of mold filling until the cooling has progressed sufficiently to allow such ejection.

Should the ejection force be applied to the molded article as long as the core is still soft, there is the danger that the article will be deformed in the region of the applied force, thereby rendering the article unusable and requiring its discard.

The working cycle of the injection molding machine is thus a function of the cooling time for the individual or successively produced articles.

Especially when thick-walled injection molded articles are to be produced, the cooling time per article can reduce the cycling time of the machine so that the capacity thereof is diminished below economical levels.

It is known to attempt to increase the cycling time of the machine by a forced cooling of the injection molded articles. However, the problem with this techniquie is that high-speed cooling of the injection-molded article, especially when it is large or formed from complex parts, can result in inhomogeneitus, stress regions and distortion zones because of thermal phenomena. The resulting reduction in the quality of the product causes the number of rejects to be large.

In fact, in practice, complicated-contour molded articles make use of heated molds or so-called hot-runner molds to insure the homogeneity of the injection-molded articles.

A process which involves the heating of the mold, the cooling of the mold and the subsequent reheating of the mold for the next cycle, increases the energy cost beyond economical or reasonable expectations and does not significantly reduce the cycling time of the machine.

OBJECTS OF THE INVENTION

It is the principal object of the present invention to provide a periodically operable system for injection molding over a long period of time a sequence of thermoplastic articles which is economical and enables a shortening in the cycling time of the machine.

It is also an object of the invention to provide an injection-molding machine which reduces the cycling time and has increased output.

It is still another object of the invention to provide an injection-molding system which can be operated more economically, with reduced cycling time and increased output.

Still a further object of the invention is to provide an apparatus for the production of thermoplastic injection molded articles which has a higher output of articles meeting close manufacturing tolerances, free from distortion and of a reduced reject rate.

SUMMARY OF THE INVENTION

These objects and others which will become apparent hereinafter are attained, in accordance with the present invention, by a system in which, after the cooling of the outermost contours or surface regions of the homogeneously molten injected synthetic resin material in the mold cavity beneath their flow limit or temperature, the mold cavity is opened, the injection-molded article is engaged by a transition device and is held thereby until the outermost contour of the injection molded article formed in the mold cavity in the next operation has been cooled below its flow limit in the same manner. The retaining (transition) device then can engage the newly formed injection molded article and can discharge (eject) the one previously held therein.

According to the invention, therefore, it is not necessary to delay the opening of the mold cavity until the injection-molded article has been fully hardened to its core.

Surprisingly, the opening of the mold need be delayed, in accordance with the system of the present invention, only until the outermost surface regions of the injection-molded article are cooled below the flow limit, i.e. the temperature at which autonomous plastic flow of the material can occur. The interior portions of the molded article can remain soft and practically flowable without thereby limiting the system of the present invention which makes use of the fact that the outer surface regions are sufficiently congealed, under the condition stated, that they constitute a practically rigid

shell engageable without deformation by the transition device.

Thus, the injection-molded article after opening of the mold, can be engaged by a device which is capable of retaining the molded article with no undesired deformation thereof. For instance, this device can have a cavity or bed having the configuration of the molded article (i.e. generally a configuration complementary thereto), so that the internally still-soft injection-molded article is not subjected to distortion forces.

Specifically, the article-retaining device can be constituted with one of the mold halves previously forming the mold cavity.

In any event, the article is moved from the station in which it is formed to a station offset therefrom and can be displaced, according to the invention, relatively rapidly to allow re-closure of the mold. During the movement of the internally soft article, and while the latter is offset from the molding station, the article can be subjected to relatively cold ambient air. This promotes the cooling of the article to its core. In this case, heat is dissipated from the hardened wall or surface of the article and is transferred by conduction from the still soft interior to the surface at which the heat is dissipated by contact with the air. Naturally, where the article is in contact with a solid surface, it can be cooled further by the cooling of the coolant therethrough; only then do the ejectors discharge the article held by the retaining device.

Since the injection-molded article is retained in the device at least for a period sufficient to enable the outer periphery of the next article to be cooled below the flow limit, there is a sufficient degree of further cooling in this device that the article is ejected under the same conditions as have hitherto been common for ejection of a fully cooled article from the mold cavity. However, in this case, the ejection takes place from the intermediate retaining device.

Especially when thick-walled injection molded articles are produced, it has been found to be advantageous to promote the cooling of the article in the intermediate retaining device. To this end, means can be provided for contacting the injection molded article with a coolant. The cooling fluid, which can be a liquid, is applied at a rate corresponding to the wall thickness of the body to be cooled.

The use of a coolant serves to reduce the cycling time of the injection-molding machine still further since the mold itself need only pick up a lesser proportion of the heat from the injection molded article and thus can be opened in a shorter time for removal of the article and preparation to receive the next molded article.

Depending upon the size of the injection-molded article, the coolant can be selected to provide the desired cooling time for the injection molding cycle. In other words, the cooling time can be selected to correspond to the injection time by proper choice of the coolant.

It has been found to be desirable to use as the coolant a substance capable of abstracting large amounts of heat from the body contacted with the coolant. Preferably, the coolant is a liquefied deep-cooled gas, for example, applied in a liquid state to the body to be cooled. Naturally, the low temperature fluid can be applied in the gaseous state or as a mixture of gas and liquid, i.e. the type of mixture formed upon evaporation of a portion of the liquefied gas.

With thin-walled parts, the coolant can be water, atomized water, brine or air.

The use of a coolant in the manner described has been found to increase the operating rate of conventional injection molding machines and to make the operation thereof more economical.

The use of liquefied or deep-cooled gases for the augmented cooling of the injection molded articles allows, under certain circumstances, the resulting cold gases to be used for cooling the mold itself. The utilization of the liquefied gas is thus improved in such systems.

For the sequential but repetitive production of objects in which elements are embedded in the injection molded synthetic-resin material, i.e. wherein the embedded elements are metal inserts and the articles are switches and the like as may be used in the electrical or electronic industries, it has been found to be advantageous, after ejection of the molded article from the retaining device, to enable the retaining device to pick up the element to be inlaid or inserted into the molded article and to carry the same to the molding station for inclusion in the mold cavity. The working cycle of the injection molding machine even during the production of such molded articles can be reduced in this manner.

An apparatus for carrying out the method of the present invention comprises an injection-molding machine whose two (or more) part mold comprises an injection-side mold element and a closure-side element. Depending upon the shape of the body to be injection molded, the mold can also include a core. In the usual manner, the injection-mold element can comprise a fixed mold-carrying plate on the injection side of the apparatus while the closure-side mold member can be mounted on a mold carrying plate which is shiftable toward and away from the stationary mold-carrying plate. The injection-mold member can communicate via the injection nozzle with the injection molding machine (i.e. the injection unit) whereas the closure-side mold member can be provided with the ejectors.

According to the invention, the injection-side mold-carrying plate is formed with at least one mold cavity and at least two working or transition devices preferably disposed at the same height as the mold cavity and offset therefrom to opposite sides. The closure-side mold-carrier plate can include at least two closure-side molds.

After displacement of the movable mold-carrier plate away from the stationary mold-carrier plate, the movable mold-carrier plate can be laterally shiftable, i.e. shiftable in a direction transverse to its mold-closing direction, so that each closure cavity carrying a respective injection molded article which has been only surface cooled and solidified, is aligned with the receptacles formed by the treating stations and, upon readvance of the mold-closure plate toward the stationary mold-carrying plate, an empty cavity of the mold-closure plate is aligned with and cooperates and mold cavities being disposed so that mold cavity which can be filled during the next cycle. During this cycle and upon displacement of the mold closing plate in the mold closing direction, therefore, the previously formed article is carried into one of the treating stations and can be subjected to high-efficiency cooling by jets of coolant trained thereon.

During the opening stage, while the slightly solidified injection molded article is withdrawn from the fixed mold cavity, chilled and further-cooled article simulta-

neously withdrawn from the treating station, can be ejected by operation of the ejector means which can include the core mentioned previously.

When this process is next repeated, the newly formed injection-molded article can be carried into the second treating station while a third article is produced in the now-closed mold cavity.

By the provision of at least two treating devices and at least two mold cavities on the movable mold-carrying plate, it is possible during cooling of one of the injection molded articles in the treating station to simultaneously injection mold another article in the closed mold which need only abstract a small degree of heat from this newly produced molded article.

Naturally, it is possible in this manner to simultaneously produce two types of injection-molded articles with injectable materials of different type or color if the stationary mold-carrying plate is formed with two fixed mold members each of which communicates with a respective extruder, the two extruders and mold cavities being disposed in this way that to either side of each of the stationary mold cavities a respective treating station can be provided.

According to yet another embodiment of the invention, two stationary mold cavities and three treating stations are provided, one of the treating stations being disposed between the stationary mold cavities while the other two treating stations flank the stationary mold cavities and are disposed outwardly therewith. In this embodiment, the distance (center to center) between each outer treating station and the proximal mold cavity of the stationary mold plate is equal to the distance between the central treating station and the two mold cavities on the latter. In this case, the movable mold plate can have two article-receiving stations and two molded articles can be formed simultaneously.

According to still another embodiment of the invention, for the simultaneous injection molding of two bodies of synthetic resin materials of different types or colors, two stationary mold cavities are provided on the injection-side mold-carrier plate and two working stations, i.e. a pair of working stations, can be provided to either side of the pair of stationary mold cavities. The movable mold-carrying plate need thus only be provided with four receptacles for the injection molded articles and can be shifted from side to side in the manner previously described.

According to still a further feature of the invention, each of the treating installations or stations is supplied with a cooling medium and serves as a cooling device. Naturally other combinations of the systems described can be used.

The cooling devices should be provided with an internal contour which corresponds substantially to the outer contour of the injection molded article, i.e. is of a complementary shape thereto but is spaced therefrom and is formed at a plurality of locations with spray nozzles for the cooling medium. The cooling medium can thus be distributed uniformly over the surface of the injection-molded articles to effect a particularly homogeneous cooling of these articles in a brief time.

Naturally, in the manner described previously, when embedded articles are to be produced, the treating stations can also be used to feed the elements to be embedded in the injection molding material to the movable mold plate so as to be carried thereby into the mold cavities. In this case, the treating stations can constitute feed devices for these articles.

When large injection molded bodies with embedded articles are to be made, it has been found to be advantageous to constitute the treating devices both as cooling units for the articles and as feed devices for the elements to be embedded in the synthetic resin material. In either case, the feed devices can be automatic and synchronized with the working cycle of the injection molding machine.

It has been found to be advantageous to use the principles of the present invention to make closure caps or covers for bottles, jars and the like. In this case, the injection molded article must have an internal thread. In the fabrication of such articles it is advantageous to provide the movable mold-carrying plate with a threaded core which can be provided with means for unscrewing the article after cooling so that the threaded core may also serve as the ejector means.

Advantageously, the closure side of the mold-carrying plate is provided with bores in which the threaded cores are rotatably journaled so that the cores can be shiftable with the mold-carrying plate. Naturally, the threaded cores can connect with the means for rotating same only in the working stations or treating stations, if desired, to enable the threaded cores to function as ejectors. Thus, when the closure caps are sufficiently cooled in the treating devices, the means for rotating the threaded cores can be operated to eject or dislodge the caps and enable them to fall from the mold.

To shift the closure-side mold-carrying plate laterally, the side of this plate turned away from the stationary mold-carrying plate can be guided on a carriage or support. The support itself can be displaceable toward and away from the stationary mold-carrying plate, i.e. in the mold-opening and mold-closing direction and can cooperate with limit switches or the like which operate electronically to enable cycling of the machine and to insure that the carrier will reach its end positions properly.

BRIEF DESCRIPTION OF THE DRAWING

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is a diagrammatic cross-sectional view illustrating an embodiment of an injection molding machine according to the invention having two treating stations disposed on opposite sides of a fixed molding station on the fixed mold-carrying plate;

FIG. 2 is a cross-sectional view through another injection molding machine according to the invention for producing internally-threaded caps and in which the treating stations function as cooling stations for the caps;

FIGS. 3*a* and 3*b* are diagrams illustrating two other embodiments of machines according to the invention; and

FIG. 4 is a cross-sectional view of another machine embodying the invention, showing only the treating stations thereof.

SPECIFIC DESCRIPTION

FIG. 1 shows an injection molding machine in which the injection cylinder is connected at **100** to an injection nozzle **7** of a stationary mold-carrying plate **1** which is formed centrally with a stationary injection mold half **3** defining a cavity **101** adapted to be filled with injection molding material, i.e. thermoplastic synthetic resin.

The mold cavity **101** is flanked by a pair of work stations represented generally at **8** and **9** such that the center-to-center distance D between each work station and the mold cavity **101** is equal to the corresponding distance between the other work station and the mold cavity.

In the embodiment illustrated, each of the work stations is formed on an arm **102, 103** of the stationary mold-carrying plate **1**.

Each of the work stations **8, 9** comprises a shell **104, 105** adapted to receive the injection molded article, e.g. that shown at **6b**, with a clearance to enable jets of a coolant to be introduced into the space and to contact the surfaces of the molded body. To this end, the shell is formed with spray nozzles **10** which are distributed over the entire surface of the shell and train respective jets of the coolant against juxtaposed surfaces of the injection molded article.

Preferably, the shell **104, 105** is complementary to the configuration of the injection molded article although it is somewhat larger, to provide a clearance. In other words, the surface of the shell **104, 105** is geometrically similar to the outer surface of the injection-molded article to be received therein.

The injection-molding machine thus comprises a pair of work stations **8** and **9** at the same level as the stationary mold half **3** but equispaced therefrom. The shells **104** and **105** can be constituted as cooling masks.

The mold-carrying plate on the mold-closing side of the machine is shiftable toward and away from the stationary plate (arrow A) by means not shown but conventional in the art. Such means can include hydraulic piston-and-cylinder arrangements capable of developing the necessary mold-closing force.

The mold-carrying plate **2** comprises a pair of closeable mold halves represented at **4** and **5** whose center-to-center distance is equal to the center-to-center distance D previously mentioned.

On its side turned away from the stationary plate **1**, the plate **2** is guided laterally (arrow B) on a carrier **11** which, in turn is shiftable in the closing direction A in the usual guide or support elements **12**. The guide or support elements **12** thus form a track for the mold plate which is perpendicular to the track **107** formed by the carrier **11** for the plate **2** in the direction of arrow B.

Limit switches Sw can control the movement of the plate **2** relative to the carrier **11** laterally and corresponding limit switches may control the reciprocation of the carrier **11** on the guides **12**.

The limit switches thus insure that the mold halves **4** and **5** are always properly aligned or in registry with the stationary mold half **3** or the working stations **8** and **9**.

Indexing means can be provided for indexing both the carrier **11** and the plate **2** in the limiting or end positions thereof.

The drive means for the plate **2** and the carrier **11** can be, in addition to the hydraulic system previously described, chain drives, belt drives, rack and pinion drives, screw drives or the like. Such drive systems are well known in the art and need not be described in greater detail hereinbelow.

An ejection system is formed by a pair of ejector pins **15** which are carried by rode **13** interconnected by a yoke **14** engages an adjustable stop **17** on the downward movement of the plate **11**, the pins **15** are driven upwardly to eject the article **6b**.

The pins **15** are slideable in respective bores **108** of the mold plate **2** and come into alignment with heads **109** at the ends of the rods **13** when the mold halves **4** and **5** are disposed in one of the working stations.

The operating sequence is as follows:

Assume that the plate **11** and the plate **2** are in the position shown in FIG. **1** and a mass of injection-moldable material **6a** has been introduced into the mold cavity **101** defined between the mold halves **3** and **4**. During this molding operation, a previously formed article **6b** is disposed in the working station **9**.

While the surface of the article **6a** is consolidating and cooling to form a superficial hardened shell, the article **6b** is subjected to intensive cooling by jets of liquefied gas introduced via the nozzles **10**.

When the article **6a** has been superficially cooled, the carrier **11** is drawn downwardly (arrow A) until the yoke **14** strikes the right hand stop **17**, thereby ejecting the molded article **6b**. The ejection rods **13** are then retracted by spring **16** upon advance upwardly of the plate **11** while the plate **2** shifts to the left. As mold closing is completed, the mold half **5** is in registry with mold half **3** to define a new mold cavity while the article **6a** is located in the working station **8**.

A new mass of plastic material is injected into the closed mold cavity while jets **10** direct the liquefied gas coolant against the article **6a**.

When the surface of the newly injected body in the empty mold cavity is cooled sufficiently to solidity only the surface zones, the carrier **11** is again retracted, the ejector pins **13, 15** at the left hand station eject the article **6a**, the plate **2** shifts to the position shown in FIG. **1** and the mold is again closed for repetition of the cycle.

In the system illustrated in FIG. **2**, the stationary mold plate **201** is formed with a stationary mold cavity **203** having the configuration of the exterior of a screw cap. A nozzle **207** delivers the moldable material from an injection cylinder **200**.

The plate **201** carries, at the same level as the mold cavity **203**, a pair of cooling masks **208, 209** forming work stations equivalent to those described in connection with FIG. **1** and provided with coolant nozzles **210**.

In this embodiment, the mold plate **202** is formed with a pair of mold halves **204, 205** whose center-to-center spacing is equal to the center-to-center spacing between the stationary mold cavity **203** and each of the work stations **208, 209**. In this embodiment, however, a core is formed by a threaded mandrel **20, 22** which is provided with gearing **21, 23** below the plate **202** for engagement by a drive (not shown) serving to eject the molded article **206a** or **206b**.

The plate **202** is laterally shiftable on a carrier **211** which is formed with a slot **24** enabling the cores **20** and **22** to be entrained with the plate **202**.

The system of FIG. **2** operates in a manner similar to that of the system of FIG. **1** except that the ejection of the cooled cap **206b** is effected by retracting the plate **11** until the gearing **23** of the threaded core **22** engages the gear **26** of a motor **25**. The latter is then driven to spin off the cap **206b**. After ejection of the cap **206b**, the core **22** is brought back into its starting position by reverse rotation. The plate **202** is displaced to the left and the process repeated, i.e. a new cap is injection molded in the closed cavity formed between the mold halves **203, 205** while the body **206a** is cooled in station **208**.

Naturally, instead of a linearly reciprocal plate **202**, the latter can form part of a turntable of arcuate-displacement unit so that the various mold halves **204, 205** are successively aligned with mold cavities **203** and

working stations 208 or 209 upon angular displacement or indexing of the plate.

Instead of gearing 21, 23 on the screw cores 21, 22, they can be coupled to the ejector drives by belts, friction wheels, V-belts or the like.

Such belt drives can be engaged or disengaged by tensioning or detensioning, respectively, as required.

In FIG. 3a we show, diagrammatically, an injection molding apparatus which comprises two injection-molding assemblies each including a respective injection cylinder as represented at 300a and 300b, feeding a respective mold half 3 which can be aligned with paired mold halves 4 or paired mold halves 5, both pairs of movable mold halves being carried on a common plate 302.

In the embodiment of FIG. 3a, therefore, to each side of the stationary mold halves 3, there are provided a respective pair of working stations 8 or 9.

In operation, therefore, with the plate 302 in the position illustrated in FIG. 3a, the injection molding cylinders 300a and 300b, which can operate with injection-molding materials of different type or color, can produce respective molded bodies using the mold halves 4 which are in registry therewith. While the surface regions of these molded articles are cooled to render them mechanically stable, previously formed molded articles carried by the mold halves 5 are chilled or further cooled in the working stations 9.

Upon retraction of the carrier for plate 302, ejection of the molded articles from mold halves 5 and shifting of the plate 302 to the left, the previously mentioned, newly molded articles are cooled in the working station 8 while new articles are formed in the injection molds defined between the mold halves 3 and the registering mold halves 5.

Still another system allowing a plurality of molded articles to be produced during each cycle, has been shown in FIG. 3b which requires only three working stations. In this embodiment, the outer working stations are represented at 8 and 9, respectively, while a central working station is shown at 9'. The center to center distances between the working stations and the stationary mold halves 3 are all equal in this embodiment as well. Each of the mold halves 3 can cooperate with a respective conventional molding cylinder 300a, 300b for material of different composition or color.

In this embodiment, however, the laterally shiftable mold plate 402 is provided with the mold halves 4 and 5 in alternating relationship. The mold plate 402 here need only be shifted by a distance equal to the center-to-center distance mentioned previously.

When the mold plate 402 closes against the stationary mold plate, articles can be formed in the mold cavities defined between the stationary molds 3 and the mold halves 4 while previously molded articles are cooled in the working stations 9 and 9', being carried by the mold halves 5.

Upon retraction of the plate 402, the articles are rejected from the mold halves 5 and the plate can be shifted to the left so that new articles are formed in the closed molds defined between the mold halves 3 and 5. The previously formed injection molded articles are, of course, cooled in the working stations 8 and 9'.

In FIG. 4, we have shown a working station in which the cooling mask 509 is formed with the passages 510' which communicate with the nozzles 510 whereby a liquefied gas coolant, e.g. liquid nitrogen from a bottle 530, can be sprayed onto the injection molded article which is advanced into the chamber 509' enclosed by the mask 509.

A valve 531 enables the liquid nitrogen to be admitted into the chamber 509' only when the mold plate 502 has carried the molded article into the latter.

The mask 509 is here afixed laterally to an arm 501 of the stationary mold plate and is formed with a central opening 532 adapted to receive a plug 533 carried on a tubular shank 534 and displaceable in the direction of the arrow D. The tubular shank 534 communicates via a port 535 at the face of the plug 533 illustrated at 536 so that liquid coolant from a distributing valve 537 can be introduced into the chamber 509'. The valve 537 can also selectively connect the central bore 538 of the shank 534 with a suction pump 539 so that the member 533, 534 can pick up an insert 540 adapted to be embedded in the synthetic resin article.

The plate 502 can be formed with the ejector pins 515 which may operate as described in connection with FIG. 1.

The plate 502 is shown in its retracted position, i.e. its carrier has been displaced away from the stationary mold plate and the previously molded article, after cooling, has been ejected and the pins 515 have been reset in the plate 502. In this position of plate 502, the device 533, 534 can be advanced in through the opening 532 to deposit the insert 540 to be embedded in the synthetic resin material onto the mold member 505 formed on the plate 502. Thus the device 533, 534 constitutes feed means for placing inserts upon the mold members 505 so that these inserts may be ultimately embedded in the synthetic resin material when the mold cavities 505 are aligned with the stationary mold cavities of the stationary plate.

We claim:

1. An injection molding apparatus comprising

a stationary mold plate formed with a stationary mold element adapted to define a mold cavity;

injection means communicating with said mold cavity through said stationary mold element for injecting a mass of synthetic-resin material into said mold cavity to form an injection-molded article;

a movable mold plate displaceable toward and away from said stationary mold plate for mold-closing and mold-opening operation, said movable mold plate being formed with at least two sapced-apart movable mold elements each defining said mold cavity with said stationary mold element upon registry of the respective movable mold element therewith and advance of said movable plate in the mold-closing direction, said plates being further relatively shiftable to register each of said movable mold elements with said stationary mold elements alternately;

a pair of work stations each adapted to receive a said article carried in one of said movable mold elements upon displacement of said movable plate in said mold-closing direction when the other movable mold element defines said mold cavity with said stationary mold element the work station being provided with an internal contour which corresponds substantially to the outer contour of the injection molded article but is spaced therefrom forming a cavity between said injection molded article and said work station;

means to inject a coolant into said cavity

means for retaining a mass in said mold cavity substantially only for a period sufficient to cool the

surface regions of said mass to a temperature below the flow temperature thereof and then removing the resulting article from said cavity and transporting same into one of said working stations offset from said mold cavity while ejecting said previously formed article from its working station and simultaneously with the introduction of the article formed from said mass into one of said working stations, closing said mold cavity and injecting another mass of synthetic-resin material therein.

2. The apparatus defined in claim 1 wherein the means to inject a coolant comprises nozzles for training jets of said coolant onto said article.

3. The apparatus defined in claim 1 wherein at least one of said working stations is formed with means for feeding inserts to be embedded in the synthetic-resin material onto said movable mold elements.

4. The apparatus defined in claim 1 wherein the movable and stationary mold elements define a mold cavity having the configuration of a closure cap, said movable plate being provided with an externally threaded core at each of said movable mold elements to form internal threads for said closure caps.

5. The apparatus defined in claim 4 wherein said cores are rotatable in said movable plate and are formed with means engageable to rotate said cores and discharge said caps from said movable mold elements.

6. The apparatus defined in claim 1 wherein said movable plate is shiftable transversely to the mold-closing direction on a carrier, said carrier being displaceable in said mold-closing direction.

7. The apparatus defined in claim 6, further comprising limit switches controlling the displacement of said plate on movable said carrier and the displacement of said carrier.

8. The apparatus defined in claim 6, further comprising ejector means on said carrier opposite said working stations and cooperating with said plates for dislodging articles cooled in said working station from said movable mold elements.

9. The apparatus defined in claim 8 wherein each of said working stations includes a mask adapted to receive said articles, and nozzle means in each of said masks for directing jets of liquefied gas against an article disposed in the respective mask.

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